AD-A060 010 ARMY INVENTORY RESEARCH OFFICE PHILADELPHIA PA F/G 15/5
PROBABILITIES OF ZERO DEMAND.(U)
SEP 78 S FRAZZA
UNCLASSIFIED IRO-TR-78-5 NL

END
DATE FILMED
12-78
DDC

[redacted]

(6) PROBABILITIES OF ZERO DEMAND /

(9) TECHNICAL REPORT /5

BY

(10) SALLY FRAZZA

(11) SEPTEMBER 1978

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

(12) 17 p. (14) IROA-TR-78-5

US ARMY INVENTORY RESEARCH OFFICE
US ARMY LOGISTICS MANAGEMENT CENTER
ROOM 800 US CUSTOM HOUSE
2ND AND CHESTNUT STREETS
PHILADELPHIA, PA 19106

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PROBABILITIES OF ZERO DEMAND		5. TYPE OF REPORT & PERIOD COVERED Technical Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Sally Frazza		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Inventory Research Office, ALMC Room 800, US Custom House 2nd & Chestnut Streets, Philadelphia, PA 19106		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Materiel Development & Readiness Command 5001 Eisenhower Avenue Alexandria, VA 22333		12. REPORT DATE September 1978 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Information and data contained in this document are based on input available at the time of preparation. Because the results may be subject to change, this document should not be construed to represent the official position of the US Army Materiel Development & Readiness Command unless so stated.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Demand Data
Demand Forecasting

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report estimates the zero demand probabilities over two years and over longer periods using IRO's Demand History File of AVSCOM (TSARCOM) data.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PURPOSE

A zero probability is the probability of no demands in two future years given a demand frequency in a two year base period. This study estimates zero probabilities using the IRO AVSCOM (TSARCOM) demand history file. C. Herrera* did a similar study using TACOM (TARCOM) data and her work is the model for this study.

There are four objectives:

(1) To duplicate the work done at TACOM.

(2) To determine if unit price and requisition size have an effect on the probabilities.

(3) To determine if a bias is created by limiting the sample of items to those with a demand in the last quarter of the base period.

(4) To estimate the zero probabilities over longer future periods - three and four years.

DATA

The IRO demand history file includes 11 years of demands by quarter taken from the 2-year Demand Return & Disposal (DRD) files from 1967 thru 1977. (The 1966 data was not included.) In order to minimize the potential error involved in combining data over such an extended period, an item was dropped if we lost track of its demand history and had no concrete evidence that it became terminal or obsolete. All items were matched against the Reference Number (REFNO) file corresponding to the end of each 2-year DRD. Most of the items not found on a given REFNO had been coded terminal or obsolete on the previous REFNO and were retained. For this study, of 11994 items with demands in the 74-75 base period, and which were not coded terminal or obsolete at the end of 75, only 137 were skipped because they could not be found on the 77 REFNO.

To compute the zero probabilities we looked only at items with from 1 to 25 requisitions in the base period and which were not coded terminal or obsolete as of the end of the base period. For the 74-75 base we had a sample of 11857 items (11994-137).

---

*Report No. 75-35 "COSDIF Probabilities for TACOM."

DUPLICATING TACOM WORK

As was done at TACOM, we grouped the items by demand frequency in the base and computed the zero probability for each frequency class as the fraction of the items in the class which had no future demands. For the entire sample of 11857 items, 8490 had demands in the future and 3367 had no demands. The overall zero probability of the sample is 3367/11857 = .28.

The demand frequency of an item was computed by two methods. Method 1 considers all items with 2N-1, 2N, 2N+1 requisitions in the two year base as having a demand frequency of N. This method increases the sample size as items with an odd number of requisitions get counted twice. Frequency class 5 includes items with 9, 10, 11 requisitions. Frequency class 6 includes items with 11, 12, 13 requisitions. An item with 11 requisitions is included in both groups.

Method 2 considers each item only once and does not include items with 25 demands in the base. Frequency class N includes items with 2N-1, 2N requisitions in the two year base. Items with 23 or 24 requisitions go into frequency class 12.

The rationale behind the two methods is explained in the TACOM report. As is expected, Method 2 produces slightly larger zero probabilities. Since probabilities decrease as demand frequency increases, a sample of items with 23, 24, 25 will have lower zero probability than a sample with 23, 24.

TESTING EFFECT OF UNIT PRICE & REQUISITION SIZE

We wanted to see if the variables unit price and average requisition size have an influence on the zero probabilities. For this effort the frequency were determined by method 1 only. For unit price we looked at three subgroups within each frequency class: UP < $100, UP from $100 to $1000, and UP > $1000. Out of the total sample of 15420 items (by method 1, items with an odd number of requisitions get used twice), 11074 had UP less than $100 - 72%, 3438 had UP between $100 - $1000 - 22%, 908 had UP greater than $1000 - 6%. The unit price used was from the 77 NSNMDR.

For average requisition size we divided each frequency class into two subgroups: average requisition size equal to 1, and average requisition

size greater than 1. Out of 15420 items:

5705, 37%, had average requisition size = 1

9715, 63%, had average requisition size > 1

For each of the five subgroups, three for unit price and two for average requisition size, we ran a χ^2 test to determine if the observed number of zero demands for each frequency class was statistically different from the expected number, when using the estimated class probabilities from the total sample. Since the data thins out for the higher frequency classes, classes 6-12 were grouped together and treated as 1 class. The sums were compared to χ^2 with 5 df. This does not fully measure the significance of the differences between subgroups, since each subgroup is a part of the total sample.

We ran two more χ^2 tests: (1) To see if the items with average requisition size > 1 fit the probabilities for items with average requisition size = 1 and (2) to see if the items with UP < \$100 fit the probabilities for items with UP > \$1000. In both cases we are testing to see if the largest subgroup fits the probability for the smallest subgroup.

EFFECT OF DEMAND IN LAST QUARTER OF BASE

It might be expected that a demand in the last quarter of the base period would forstall future demands, thus increasing the zero probabilities. A customer having just ordered would be well stocked and not need to order again for two years. On the other hand, perhaps in forecasting future demands the base period demands should be weighted according to their age, giving most weight to the most recent demands. If this is the case, a demand in the last quarter would decrease the zero probabilities.

We recalculated the two year zero probabilities including only those items with a demand in the last quarter of the base. There were only 4409 such items, and by method 1 we get a sample of 6353 items.

EXTENDING THE FUTURE

For an item with demands in a two year base period what is the probability of no demand in three years and of no demand in four years? To compute these probabilities we used a 72-73 base period. The two year zero probabilities were recomputed using the 72-73 base, and we found the probabilities to be

higher than those computed with the 74-75 base. Going back to some of the original data processing done to create our data base we found a drop in demands during 74-75.

In 72-73 we had 1,134,255 demands.

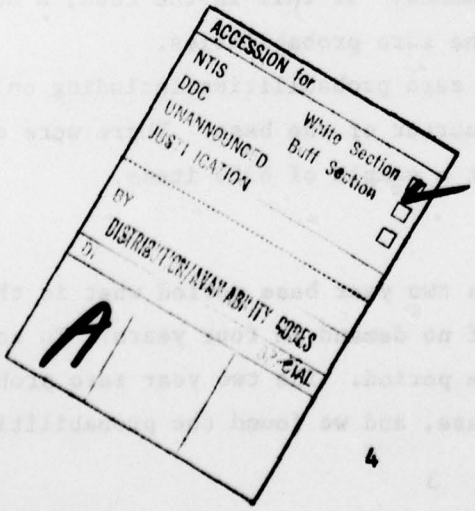
In 74-75 we had 1,009,517 demands.

In 76-77 we had 965,521 demands.

The 76-77 demands are 96% of the 74-75 demands which in turn are only 86% of the 72-73 demands. The drop in 74-75 may explain the higher zero probabilities when 72-73 was used as the base.

As before, we included only items with 1-25 requisitions in the base and which were not coded obsolete at the end of 73. There were 14390 such items. Thirteen of these were skipped because they were not on the 75 REFNO, leaving 14377. Using method 1 to figure the frequency classes gives a sample size of 18822 items.

In addition to the zero probabilities we also computed the conditional probability of having a demand in the third year given none in the first two and the conditional probability of a demand in the fourth year given none in the first three. The first of these is the number of items with zero demands in two, but not in three years divided by the number of items with zero in two years.



CONCLUSIONS

a. The AVSCOM (TSARCOM) probabilities as we calculated them are very similar to TACOM's (TARCOM). When we used 74-75 as the base period, our probabilities, with the exception of the first frequency class, are slightly lower than TACOM's. When we used 72-73 as the base period the AVSCOM probabilities are higher than TACOM's over all frequency classes. The TACOM probabilities were computed using a 72-73 base.

We are comparing our figures to those computed by TACOM which exclude untraceable FSNs. We too excluded untraceable FSNs, but only if we did not have an indication that the item became terminal or obsolete. In relation to our total sample, we skipped considerably fewer items than TACOM. These terminal items increase our zero probabilities. If the untraceables excluded by TACOM are included in their sample, their results are even closer to ours.

b. By inspection, the zero probabilities are affected by unit price and to a lesser degree by requisition size. We did two kinds of χ^2 tests to measure the effect. The first compared each of the 5 subsets of the data with the total population, and the second compared one subset with another. The results of the first five tests are 11.58, 5.32, 8.23, 4.76, 6.64. The results of the other two are 183.43 and 22.97. The critical region for the χ^2 test with a 95% confidence level is greater than 11.071. These tests indicate that although the overall probabilities can not be judged incorrect for any subset of the total population, there is a significant difference between the subsets. Items with unit price greater than $1000 have lower zero probabilities than lower priced items. Items with average requisition size equal 1 have lower zero probabilities than items with multiple demands.

c. The effect of limiting our sample to items with a demand in the last quarter is to lower the zero probabilities. More work would be necessary to come to any definite conclusions about the relative importance of more recent demands in forecasting zero probabilities.

d. Extension of the forecast period shows three frequency classes with a 25% or greater chance of having a demand in the third year after none in the first two. The probabilities for a demand in four years after none in the first three are low. In both cases there seems to be no relationship between the conditional probabilities and the demand frequency classes.

CONDITIONAL PROBABILITIES FOR EXTENDING FUTURE

FREQUENCY	OF DEMAND IN 3RD YEAR AFTER 0 IN 1ST 2	OF DEMAND IN 4TH YEAR AFTER 0 IN 1ST 3
1	.141	.080
2	.235	.139
3	.254	.180
4	.270	.135
5	.274	.153
6	.139	.088
7	.262	0
8	.222	.114
9	.089	0
10	.100	.028
11	.136	0
12	.133	0
TOTAL	.173	.098

TABLE 1 - ZERO PROBABILITIES BY METHOD 1

AVERAGE YEARLY DEMAND FREQ.	1	2	3	4	5	6	7	8	9	10	11	12
TACOM * (72-73) ** 2 YR.	.35	.23	.14	.07	.06	.05	.04	.02	.01	.01	.01	
AVSCOM (74-75) 2 YR.	.46	.21	.11	.06	.05	.02	.02	.02	.02	.00	.01	.01
(72-73) 2 YR.	.56	.33	.21	.17	.13	.09	.08	.08	.09	.09	.05	.04
(74-75) 2 YR. (DMD IN LAST Q)	.37	.17	.09	.05	.04	.02	.02	.02	.01	0	0	.01
(72-73) 2 YR. (DMD IN LAST Q)	.34	.20	.13	.09	.05	.03	.02	.03	.03	.03	.01	.01
UP < 100 (74-75) 2 YR.	.47	.22	.10	.05	.04	.02	.01	.02	.01	0	0	.01
100 < UP < 1000 (74-75) 2 YR.	.46	.20	.11	.06	.08	.03	.04	.03	.01	0	.03	.03
UP > 1000 (74-75) 2 YR.	.36	.20	.11	.03	.03	.02	0	.02	.03	0	0	0
AVG REQ SIZE = 1 (74-75) 2 YR.	.45	.20	.11	.05	.04	.01	.02	0	0	0	0	0
AVG REQ SIZE > 1 (74-75) 2 YR.	.48	.22	.10	.06	.05	.02	.02	.02	.02	0	.01	.01
(72-73) 3 YR.	.48	.25	.16	.12	.09	.08	.06	.06	.08	.08	.05	.04
(72-73) 4 YR.	.44	.22	.13	.11	.08	.07	.06	.06	.08	.08	.05	.04

*Years indicate the base period.

**Number of years indicates the observation period.

TABLE 2 - SAMPLE SIZES BY METHOD 1

AVERAGE YEARLY DEMAND FREQ.	1	2	3	4	5	6	7	8	9	10	11	12
TACOM * (72-73) 2 YR. **	370	324	280	257	246	238	247	226	218	229	223	
AVSCOM (74-75) 2 YR.	6345	2547	1616	1143	842	685	538	441	388	316	295	264
(72-73) 2 YR.	7469	3163	1923	1393	1033	839	736	559	494	452	419	342
(74-75) 2 YR. (DMD IN LAST Q)	1076	879	743	682	567	489	418	372	338	285	264	240
(72-73) 2 YR. (DMD IN LAST Q)	1168	900	755	673	535	455	438	363	352	319	312	272
UP < 100 (74-75) 2 YR.	4628	1824	1182	827	594	463	361	310	285	215	205	180
100 < UP < 1000 (74-75) 2 YR.	1407	578	334	258	187	168	134	89	68	79	69	67
UP > 1000 (74-75) 2 YR.	310	145	100	58	61	54	43	42	35	22	21	17
AVG REQ SIZE = 1 (74-75) 2 YR.	3503	1016	497	272	147	96	65	34	28	20	14	13
AVG REQ SIZE > 1 (74-75) 2 YR.	2842	1531	1119	871	695	589	473	407	360	296	281	251
(72-73) 3 YR.	7469	3163	1923	1393	1033	839	736	559	494	452	419	342
(72-73) 4 YR.	7469	3163	1923	1393	1033	839	736	559	494	452	419	342

* Years indicate the base period.

** Number of years indicates the observation period.

TABLE 3 - ZERO PROBABILITIES BY METHOD 2

AVERAGE YEARLY DEMAND FREQ.	1	2	3	4	5	6	7	8	9	10	11	12
TACOM (72-73)* 2 YR.**	.37	.25	.17	.06	.06	.05	.04	.03	.01	.01	.01	
AVSCOM (74-75) 2 YR.	.51	.24	.12	.06	.05	.02	.02	.02	.02	0	0	.02
(72-73) 2 YR.	.59	.37	.22	.18	.14	.09	.09	.07	.07	.11	.05	.06
(74-75) 2 YR. (DMD IN LAST Q)	.44	.19	.11	.05	.04	.02	.01	.03	.02	0	0	.01
(72-73) 2 YR. (DMD IN LAST Q)	.39	.22	.14	.10	.06	.03	.03	.02	.03	.04	.01	.02
UP < 100 (74-75) 2 YR.	.51	.25	.12	.06	.04	.02	.01	.02	.02	0	0	.01
100 < UP < 1000 (74-75) 2 YR.	.51	.21	.14	.05	.10	.02	.04	.03	.02	0	0	.05
UP > 1000 (74-75) 2 YR.	.39	.21	.12	.05	.03	.02	0	.03	.05	0	0	0
AVG REQ SIZE = 1 (74-75) 2 YR.	.48	.21	.14	.05	.05	0	.02	0	0	0	0	0
AVG REQ SIZE > 1 (74-75) 2 YR.	.54	.26	.12	.06	.05	.03	.02	.03	.02	0	0	.01
(72-73) 3 YR.	.52	.28	.16	.13	.10	.08	.07	.05	.07	.10	.04	.06
(72-73) 4 YR.	.48	.25	.13	.11	.08	.07	.07	.04	.07	.09	.04	.05

* Years indicate the base period.

** Number of years indicates the observation period.

TABLE 4 - SAMPLE SIZES BY METHOD 2

AVERAGE YEARLY DEMAND FREQ.	1	2	3	4	5	6	7	8	9	10	11	12
TACOM (72-73)* 2 YR.**	251	229	191	163	177	152	171	152	149	161	151	
AVSCOM (74-75) 2 YR.	5251	1906	1173	826	598	463	387	300	273	223	193	190
(72-73) 2 YR.	6057	2403	1400	1010	729	575	515	407	342	302	295	232
(74-75) 2 YR. (DMD IN LAST Q)	766	612	511	471	400	321	295	251	237	200	175	170
(72-73) 2 YR. (DMD IN LAST Q)	809	631	523	474	378	313	295	264	243	211	214	182
UP < 100 (74-75) 2 YR.	3839	1361	856	602	424	314	260	202	205	147	138	133
100 < UP < 1000 (74-75) 2 YR.	1157	445	239	186	136	108	96	67	46	58	44	44
UP > 1000 (74-75) 2 YR.	255	100	78	38	38	41	31	31	22	18	11	13
AVG REQ SIZE = 1 (74-75) 2 YR.	3026	794	382	207	110	66	55	25	20	16	5	12
AVG REQ SIZE > 1 (74-75) 2 YR.	2225	1112	791	619	488	397	332	275	253	207	188	178
(72-73) 3 YR.	6057	2403	1400	1010	729	575	515	407	342	302	295	232
(72-73) 4 YR.	6057	2403	1400	1010	729	575	515	407	342	302	295	232

* Years indicate the base period.

** Number of years indicates the observation period.

DISTRIBUTION

COPIES	
1	Deputy Under Sec'y of the Army, ATTN: Office of Op Resch
	Headquarters, US Army Materiel Development & Readiness Command
1	DRCPA-S
1	DRCMS
1	DRCPS
1	DRCPS-P ATTN: Mr. Boehm
1	DRCMM
1	DRCMM-R
1	DRCMM-RS
1	DRCMM-M
1	DRCMM-E
1	DRCMM-L
1	Dep Chf of Staff for Logistics, ATTN: DALO-SMS, Pentagon, Wash., DC 20310
2	Defense Logistics Studies Info Exchange, DRXMC-D
10	Defense Documentation Center, Cameron Sta., Alexandria, VA 22314
1	Commandant, US Army Logistics Mgt Center, Ft. Lee, VA 23801
1	Office, Asst Sec'y of Defense, ATTN MRA&L-SR, Pentagon, Wash., DC 20310
	Commander, USA Armament Materiel Readiness Cmd, Rock Island, IL 61201
1	ATTN: DRSAR-MM
1	ATTN: DRSAR-SA
	Commander, USA Communications & Electronics Materiel Readiness Cmd, Ft. Monmouth, NJ 07703
1	ATTN: DRSEL-MM
1	ATTN: DRSEL-SA
	Commander, USA Missile Materiel Readiness Cmd, Redstone Ars, AL 35809
1	ATTN: DRSMI-S
1	ATTN: DRSMI-D
	Commander, USA Troop Support & Aviation Materiel Readiness Command, St. Louis, MO
1	ATTN: DRSTS-SP
1	ATTN: DRSTS-FR
	Commander, US Army Tank-Automotive Materiel Readiness Command, Warren, MI 48090
1	ATTN: DRSTA-F
1	ATTN: DRSTA-S
1	Commander, US Army Missile Research & Development Command, ATTN: DRDMI-DS, Redstone Arsenal, AL 35809
1	Commander, US Army Logistics Center, Ft. Lee, VA 23801
1	Commander, US Army Logistics Evaluation Agency, New Cumberland Army Depot, New Cumberland, PA 17070
1	Commander, US Army Depot Systems Command, Chambersburg, PA 17201
1	Commander, US Air Force Logistics Cmd, WPAFB, ATTN: AFLC/XRS, Dayton, Ohio 45433

COPIES

1 US Navy Fleet Materiel Support Office, Naval Support Depot, Mechanicsburg, PA 17055

1 Mr. James Prichard, Navy Supply Systems Cmd, Dept of US Navy, Wash., DC 20376

1 George Washington University, Inst of Management Science & Engr., 707 22nd St., N.W., Wash., DC 20006

1 Naval Postgraduate School, ATTN: Dept of Opns Anal, Monterey, CA 93940

1 Air Force Institute of Technology, ATTN: SLGQ, Head Quantitative Studies Dept., Dayton, OH 43433

1 US Army Military Academy, West Point, NY 10996

1 Logistics Mgt Institute, 4701 Sangamore Rd., Wash., DC 20016

1 University of Florida, ATTN: Dept of Industrial Systems Engr., Gainesville, FL 32601

1 RAND Corp., ATTN: S. M. Drezner, 1700 Main St., Santa Monica, CA 90406

1 US Army Materiel Systems Analysis Activity, ATTN: AMXSY-CL, Aberdeen Proving Ground, MD 21005

1 Commander, US Army Logistics Center, ATTN: Concepts & Doctrine Directorate, Ft. Lee, VA 23801

1 ALOG Magazine, ATTN: Tom Johnson, USALMC, Ft. Lee, VA 23801

1 Commander, USDRC Automated Logistics Mgt Systems Activity, P.O. Box 1578, St. Louis, MO 63188

1 Director, DARCOM Logistics Systems Support Agency, Letterkenny Army Depot, Chambersburg, PA 17201

1 Commander, Materiel Readiness Supply Activity, Lexington, KY 40507

1 Director, Army Management Engineering Training Agency, Rock Island Arsenal, Rock Island, IL 61202

1 Defense Logistics Agency, Cameron Sta, Alexandria, VA 22314

1 Dep Chf of Staff (I&L), HQ USMC-LMP-2, ATTN: MAJ Sonneborn, Jr., Wash., DC 20380

1 Commander, US Army Depot Systems Command, Letterkenny Army Depot, ATTN: DRSDS-LL, Chambersburg, PA 17201

1 Operations Research Center, 3115 Etcheverry Hall, University of California, Berkeley, CA 94720

1 Dr. Jack Muckstadt, Dept of Industrial Engineering & Operations Research, Upson Hall, Cornell University, Ithaca, NY 14890

1 Prof Herbert P. Galliher, Dept of Industrial Engineering, University of Michigan, Ann Arbor, MI 48104

1 Mr. Ellwood Hurford, Scientific Advisor, ATCL-SCA, Army Logistics Center, Ft. Lee, VA 23801

1 Commandant, USA Armor School, ATTN: MAJ Harold E. Burch, Leadership Dept, Ft. Knox, KY 40121

1 Prof Robert M. Stark, Dept of Stat & Computer Sciences, University of Delaware, Newark, DE 19711

1 Prof E. Gerald Hurst, Jr., Dept of Decision Science, The Wharton School, University of Penna., Phila., PA 19174

COPIES	
1	Logistics Studies Office, DRXMC-LSO, ALMC, Ft. Lee, VA 23801
1	Procurement Research Office, DRXMC-PRO, ALMC, Ft. Lee, VA 23801
1	Dept of Industrial Engr. & Engr. Management, Stanford University, Stanford, CA 94305
1	Commander, US Army Communications Command, ATTN: Dr. Forrey, CC-LOG-LEO, Ft. Huachuca, AZ 85613
1	Prof Harvey M. Wagner, Dean, School of Business Adm, University of North Carolina, Chapel Hill, NC 27514
1	Dr. John Voelker, Mechanical Engr. Bldg., Room 144, University of Illinois, Urbana, IL 61801
1	DARCOM Intern Training Center, ATTN: Jon T. Miller, Bldg. 468, Red River Army Depot, Texarkana, TX 75501
1	Prof Leroy B. Schwarz, Dept of Management, Purdue University, Krannert Bldg, West Lafayette, Indiana 47907
1	US Army Training & Doctrine Command, Ft. Monroe, VA 23651
1	Operations & Inventory Analysis Office, NAVSUP (Code 04A) Dept of Navy, Wash., DC 20376
1	US Army Research Office, ATTN: Robert Launer, Math. Div., P.O. Box 12211, Research Triangle Park, NC 27709
1	Prof William P. Pierskalla, Dept of Ind. Engr. & Mgt. Sciences, Northwestern University, Evanston, IL 60201